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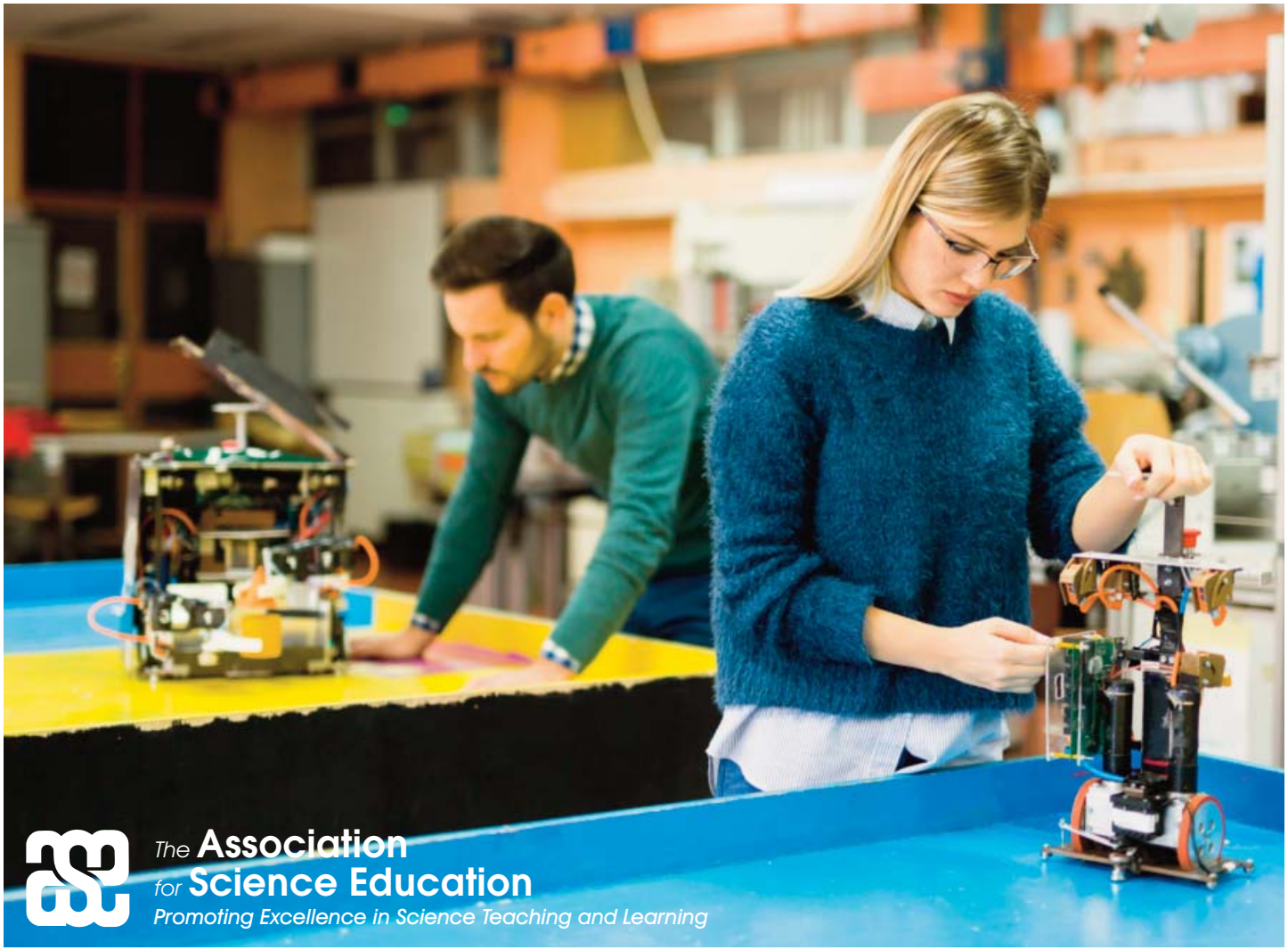

An ASE publication for all concerned with the pre-service education, induction and professional development of science teachers

Initial and Continuing Teacher Education: thoughts and experiences from a Welsh perspective

● Susan Wyn Jones

This review discusses initial and continuing teacher education from Wales's perspective. It explores initial teacher education (ITE), student teacher assessment and subject knowledge. In 1997, educational matters were devolved from Westminster to the Welsh Government. Since then the curriculum has diverged from that of England (Jones & Lewis, 2016), making Wales an interesting context in which to review science teacher education. Moreover, such a review is timely as Wales moves forward with far-reaching reform of the curriculum, ITE and teacher practice (Furlong, 2015; Donaldson, 2015).

ITE reform in Wales

Following the PISA (Programme for International Student Assessment) results for Wales, a 'spotlight' has been shone on the quality of teachers and ITE in Wales (Jones & Lewis, 2016). A succession of reviews of ITE in Wales has been commissioned by the Welsh Government (Tabberer, 2013; OECD, 2014; Furlong, 2015). Based on the latest of these (Furlong, 2015), the Cabinet Secretary for Education (in line with her predecessors) has endorsed the expectation that the current teacher education reform in Wales will play an important role in raising school standards (Welsh Government, 2016a; Welsh Government, 2016b) and complement the implementation of a new curriculum for Wales, as envisaged by Donaldson (2015).

Background

Hattie (2015, p.29) makes the case that any reform of ITE should ensure provision that *'focuses on the evidence of the impact of individual features of programmes on the capabilities of teacher candidates to enhance their students' learning'*. This principle echoes Estyn's (Her Majesty's Inspectorate of Education and Training in Wales's) revised 2015 guidance for inspection of initial teacher education in Wales, which states (2015, p.11) that providers of ITE in Wales should *'monitor standards to evaluate the impact of the quality of provision'*. Estyn also has tacit expectations (Estyn, 2015) that student teachers make rapid progress, reaching at least a 'good' standard by the end of their initial training. This concurs with Hattie's view (2015, p.11) that student teachers should be *'prepared for the immediate practice of teaching and excellent in the first few years of classroom teaching'*.

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However, the latest PISA results (Hulme, 2016) show pupils' science attainment in Wales declining and the Cabinet Secretary has told stakeholders (Williams, 2016) that *'the further drop in our score mirrors our own understanding of what has happened with science teaching and learning in Wales. To tackle these issues, in the coming months I will be announcing new ambitious plans to ensure our young people can achieve the highest standards in science'*.

The reasons for the drop in attainment in science are now being investigated. Amongst the most obvious is a lack of science teachers in Wales. Dale (2016) notes that some Heads of Science are concerned about the lack of availability of specialist and well-trained science teachers to fill posts in their departments, with non-specialist and/or non-science staff teaching some science classes. The Welsh Government is aware of this shortage of science teachers (including Welsh medium) and offers incentives to train to teach science in Wales.

Welsh Government incentives for training to teach science in Wales

As science is perceived to be a 'priority subject', the Welsh Government offers incentives to train as a science teacher at secondary school level for those with suitable degrees and qualifications (Welsh Government, 2016c). These alter from year to year; however, recent incentives for chemistry and physics have been more generous than those for biology. There have also been incentives for those training to teach science through the medium of Welsh (Bangor University, 2016) to encourage more Welsh medium science teachers into the profession. Currently, the incentives offered in Wales are lower than those offered to student teachers in England and are related to the initial degree classification and not any subsequent higher degrees. Teacher educators in Wales have stated that this makes it a 'huge challenge' to recruit science students onto a PGCE course in Wales (BBC, 2016), with numbers plummeting to a quarter of those trained five years ago.

The failure to recruit students to teach science may be one factor behind statistics from the Education Workforce Council for Wales, which

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show only 49% of physics teachers having a physics degree, 57% of chemistry teachers a chemistry degree and 62% of biology teachers a biology degree (BBC, 2016). In light of the latest PISA results, the implication is that such a lack of specialist teachers in the individual sciences is having a detrimental effect on the quality of science teaching in Wales (BBC, 2016). However, the actual picture may be more complex and involve other factors. Clearly, whatever the underlying issues, pupils in Wales deserve science teachers who have excellent subject knowledge, use effective pedagogy and have excellent all-round skills – from soft skills to literacy, numeracy and ICT.

Welsh Government literacy and numeracy requirements for training to teach science in Wales

In line with aspirations to raise the quality of those entering the profession, all prospective science student teachers in Wales must also have a 'B' in English language and mathematics at GCSE (Teacher Training and Education in Wales, 2016); those who train as primary school teachers must also have a 'C' in science double award (Welsh Government, 2016d). However, there is no restriction on schools to employ only teachers with these grades.

Current assessment of science student teachers in Wales

At present, there are several routes to becoming a qualified science teacher in Wales (Welsh Government, 2016e) (both university and school routes), with each one requiring students to reach Qualified Teacher Status (QTS). Currently, the Teaching Standards for QTS are divided into three main areas (Welsh Government, 2009), as outlined below:

- Professional Values and Practices
- Knowledge and Understanding
- Teaching

However, these Standards are under review and the new QTS Standards are likely to form part of a continuum that will support teacher practice and development beyond the first year of training, leading to *'a lifelong journey of learning by teachers over their teaching career'* (Welsh Government, 2016b, p.25). Therefore, there may shortly be more scope for newly qualified science

teachers and beyond to easily access specific professional development in science education as they progress with their careers.

Science student teachers' personal literacy and numeracy skills are assessed at interview and monitored and supported during their programme, as required by the Welsh Government (Estyn, 2015). During their teaching, they are also assessed on their ability to develop their pupils' literacy, numeracy and digital competency skills, as well as *Cymraeg pob dydd* (everyday Welsh) and subject knowledge. Programmes are required to assess student teachers' ability to critically evaluate their own practice and monitor their development as reflective practitioners (Estyn, 2015, p.13). Furthermore, their science subject-specific assignment work *'must reflect a good understanding of teaching and learning theories and good analysis of their own teaching and work in school'* (Estyn, 2015, p.17).

The following sections will discuss how subject-specific aspects, such as subject knowledge, pedagogy and Welsh Government curricula initiatives are linked to ITE in Wales:

Subject knowledge

At present, secondary science teacher education candidates in Wales are expected to have 'good subject knowledge' (Teacher Training and Education in Wales, 2016) and to have followed a science-based degree (with at least 50% of the content related to their specialism) to make an application to an ITE programme in Wales.

Estyn has been critical of the science subject knowledge of a minority of primary school teachers in Wales (Estyn, 2013, p.17) who were deemed to need further training to improve. Dale (2016) also found that secondary science teachers were sometimes critical of primary teachers, with misconceptions being passed on to large bodies of children from individual teachers.

The minimum subject knowledge that should be taught is outlined in the Welsh Government's *Science in the National Curriculum for Wales* (2016) and is known as the 'Range'. This gives the briefest outline of the required knowledge and understanding of some key science concepts, but without an indication of their relative complexity (Estyn, 2013).

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At Key Stage 4/5 (ages 14-19), the new exam board specifications are used to guide teaching and learning (WJEC, 2016) and outline the required subject knowledge with more difficult content or concepts being noted in bold. Further detailed guidance for teachers is also provided by the exam board (WJEC, 2016) to ensure clarity regarding what is required and the extent and depth of the underlying subject knowledge and understanding. Nilson and van Driel (2010) make the point that 'deep' subject knowledge is essential for student teachers to 'operationalise' effective pedagogy in science, which will be the focus of the next section.

Pedagogy

At present, the Welsh Government's *Science in the National Curriculum for Wales* (Welsh Government, 2008) emphasises the scientific enquiry skills (SES) required by learners at Key Stages 2-4 (ages 7-16). SES have been written in such a way as to integrate them with the Welsh Government's definition of thinking skills development as 'Plan, Develop and Reflect' (2010), so that investigative work also promotes thinking skills and metacognition. This emphasis on SES encourages student teachers to carry out investigative work, and teacher educators may use investigations to introduce and develop effective science teaching pedagogy (Estyn, 2013) and can help inform discussions about scientific literacy.

Teacher education courses also encourage students to explore different methods of teaching science. For example, intervention programmes such as Cognitive Acceleration in Science Education (CASE), advocated by the Welsh Government (2010, p.6) as a method to *'promote thinking in subject'* contexts, may be discussed. However, although the basic principles are promoted, pressure of time may mean that these stand-alone programmes are less likely to be encountered in school as originally hoped, although elements may survive in some specific lessons (Clowser, 2015).

Along with thinking skills development, the Welsh Government has also written guidance for teachers on assessment for learning (2010). The present teaching standards have one section devoted to assessment (Welsh Government, 2009) and the expectation is that science student teachers skilfully use assessment evidence to

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improve their pupils' learning outcomes. Because of the emphasis on assessment for learning, science student teachers' ability to set challenging learning outcomes with related success criteria are also focused upon (Clarke, 2014). However, Estyn (2013, p.7), in their thematic report on Science at Key Stages 2 and 3, were critical of the robustness of science teachers' assessment and recommended that they offer pupils more *'meaningful advice on how to improve their scientific understanding and skills'.*

Estyn is currently carrying out a further thematic inspection of science teaching at Key Stages 3 and 4 and will report in 2017. Following this, they may make specific curricular recommendations related to science; however, at present, Welsh Government curricula initiatives mainly involve literacy, numeracy and digital competence.

Current curricula initiatives in Wales

Welsh Government concerns about the standards of literacy, in English and Welsh, and numeracy skills, mainly from Wales's poor standing in PISA (Welsh Government, 2016f), led to the implementation of the now statutory Literacy and Numeracy Framework (Welsh Government, 2016g). More recently, the Welsh Government has introduced the Digital Competency Framework (Welsh Government, 2016i – at present non-statutory) to aid learners in Wales in having the skills necessary for life in the 21st century.

Welsh language requirements (Welsh Government, 2016j) mean that, as well as developing English literacy skills, all science student teachers must develop Welsh learners' *Cymraeg pob dydd* (everyday Welsh) skills. (Welsh medium science teachers must also develop their pupils' Welsh literacy skills.) All science student teachers must also incorporate aspects of *Curriculum Cymreig* (2013, p.6), which requires pupils *'to be given opportunities, where appropriate, to develop and apply knowledge and understanding of the cultural, economic, environmental, historical and linguistic characteristics of Wales'.* They should also provide their learners with opportunities to develop education for sustainable development and global citizenship (ESDGC).

PISA also reports on scientific literacy measures and the Welsh Government encouraged scientific

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literacy development in science lessons before the latest PISA (Welsh Government, 2016h). However, Dale (2016) noted that science teachers required further support, guidance and resources in this area. According to her research (2016), science teachers were not clear about the difference between developing 'literacy in science lessons' and 'scientific literacy', which may have negated their ability to assess it properly (Dale, 2016).

There have been concerns that schools' concentration on literacy and numeracy has had an impact on science teaching. Estyn (2013, p.17) noted that primary schools had not placed enough priority on science in recent years because of the '*greater focus on developing pupils' literacy and numeracy skills'*. However, the emphasis on developing literacy, numeracy and digital competence skills during science lessons is central to Donaldson's vision for a new curriculum for Wales (in *Successful Futures*, 2015). It could also be argued that these skills are an essential precursor to developing scientific literacy.

Some of Donaldson's main recommendations that may be seen to impact directly on science teaching are outlined below (Donaldson, 2015, pp.113-119):

- six areas of learning and experience, with 'science and technology' being one of these;
- cross-curricular responsibilities for all teachers, to include literacy, numeracy and digital competence;
- progression replacing key stages;
- transactional competence in Welsh for all; and
- teacher assessment to have a central role before qualifications.

Science teachers in key schools, together with Welsh Government, are now in the process of developing the curriculum, resources and training to respond to these recommendations.

Clearly science teachers will require continuing professional development (CPD) to be able to implement the changes.

Amongst Furlong's recommendations is that *'programmes establish strong links between ITE and the CPD of teachers in schools'* as, according to Furlong (2015, p.19), *'staff in university faculties and in departments of education are a major resource for the more sustained development of the teaching workforce in Wales and at present that resource is significantly under-utilised'.*

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Another of Furlong's recommendations from the BERA-RSA inquiry into research and teacher education (2014) is that all those involved in training teachers become research active. This will be the focus of the next section.

Engaging student teachers/experienced teachers with research

Furlong has done much in Wales to encourage teachers to become more research active. Furlong (BERA, 2014, 2015) expects providers in Wales to produce research-experienced teachers who understand the 'why' and 'how', not just the 'what' and 'when', of teaching (2015, p.20). Amongst his other recommendations (BERA-RSA, 2014, p.18) is that '*students should be helped to understand and explore the interconnectedness of educational theories and classroom practices and that all teacher educators should be "research active lecturers"'.* There is also encouragement to try out new classroom-based research inquiry methods, such as lesson study, etc. (Furlong, 2015, pp 14-15).

Consequently, science teacher educators in Wales are now likely to take part in pedagogical research that feeds back into their programmes. Furthermore, providers collaborate with various stakeholders (Welsh Government, consortia, science advisers, local authorities, schools, teachers, etc.) on a range of research projects, which then influence policy, practice and the ITE programmes.

Science students on ITE programmes often undertake action research-based projects. Such research is perceived to improve outcomes for learners and teachers in the immediate context (Gilchrist, 2016) and is widely used by teachers in school. University education departments also offer Masters and doctorates (both PhD and EdD) in education to further develop research capability. Their partnership mentors may also gain academic recognition for their mentoring.

Final word

The educational reforms (to ITE, the curriculum and teacher practice) make becoming a qualified science teacher now in Wales an exciting time to join the teaching profession. It is hoped that the new curriculum (and related developments) will provide science teachers with opportunities to

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teach in creative ways, which will ensure that the children and young people of Wales are developed as highly skilled scientific citizens.

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